

STUDY OF MACHINING PARAMETERS OF SURFACE ROUGHNESS IN ELECTRO DISCHARGE MACHINING OF TOOL STEEL

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We hereby declare that we have checked this project report and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

This thesis presents the study of machining parameters on surface roughness in Electro Discharge Machining (EDM) of tool steel. The operation of EDM is based on removing material from the workpiece by a series of repeated electrical discharges, produced by electric pulse generators at short interval, between an electrode and workpiece that being machine in dielectric fluid medium. The Full Factorial Design of Experiment (DOE) from software STATISTICA was used to formulate the experiment layout, to analyze the effect of each parameter on the machining characteristic, and to predict the optimal choices for each EDM parameters. The selected EDM parameters were Peak Current, IP (8 and 16 A), Pulse ON-time (2 and 24 μ s), Pulse OFF-time (2 and 3 μ s) and Servo Voltage, SV (30 and 40 V). Machining is performed on EDM Sodick AQ55L model. The Surface Roughness Tester Series Mahrsurf XR 20 is used to measure R_a . From the analysis by Full Factorial DOE, it shows that Peak Current and Pulse ON-time have significant effect to surface roughness. The analysis also determined the optimum condition of the machining parameter. The lower values of these parameters the lower surface roughness. The confirmation tests and comparison test were performed for the optimum condition for the machining characteristic. The result of comparison tests showed that the percentage of performed is not accurate but this result can be accepted because the error percentage is below 10%.

ABSTRAK

Tesis ini membentangkan pembelajaran parameter mesin ke atas kekasaran permukaan dalam electro nyahcas mesin (EDM) pada alatan besi. Proses EDM berlaku dengan menyingkirkan bahan dari bahan kerja oleh beberapa siri ulangan nyahcas elektrik yang dihasilkan daripada penjana denyutan elektrik pada sela waktu pendek di antara satu elektrod dan bahan kerja yang dimesin dalam medium cecair dielektrik. Kaedah Faktorial Penuh Rekabentuk Eksperimen (DOE) dari program STATISTICA digunakan bagi merekabentuk eksperimen, menganalisis kesan setiap parameter terhadap kriteria selepas pemesinan dan jangkaan keputusan yang optimum kepada setiap EDM parameter. EDM parameter yang telah dipilih adalah Arus Puncak, IP (8 dan 16 A), Tempoh Hidup Denyutan (2 dan 24 μ s), Tempoh Mati Denyutan (2 dan 3 μ s) dan Voltan Servo, SV (30 dan 40 V). Kerja pemesinan dilakukan dengan EDM model Sodick AQ55L. Penguji kekasaran permukaan iaitu Mahrsurf XR20 digunakan untuk mengukur R_a . Daripada analisis Faktorial Penuh DOE, ia menunjukkan bahawa Arus Puncak, IP dan Tempoh Hidup Denyutan memberi kesan utama pada kekasaran permukaan. Analisis juga dapat menentukan keadaan optimum pada parameter mesin. Semakin rendah nilai parameter ini semakin berkurang kekasaran permukaan. Ujian pengesahan dan ujian perbandingan telah dijalankan mengikut keadaan optimum yang telah ditentukan untuk kriteria pemesinan. Keputusan ujian perbandingan menunjukkan peratusan ralat perbezaan yang diperolehi tidak begitu tepat tetapi keputusan masih boleh diterimapakai kerana perbezaan peratusan ralat di bawah 10%.

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LIST OF SYMBOLS

IP	Peak Current, ampere
SV	Servo Voltage, Volt
SR	Surface Roughness
MRR	Material Removal Rate
SF	Surface Finish
SQ	Surface Quality
R _a	Coefficient for surface roughness
SS	Statistical Significant
df	Degree of Freedom
p	Probability
F	Function
C	Constant

LIST OF ABBREVIATIONS

EDM	Electro Discharge Machining
HAZ	Heat Affected Zone
PM	Powder Metallurgy
HF	High Frequency
RF	Radio Frequency
AISI	American Iron and Steel Institute
DOE	Design of Experiment
ANOVA	Analysis of variance

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Nowadays, the application of advanced machining processes in manufacturing industry is become more important for company to produce the better or good products that satisfy the customer. This machining will solve all the problems that happened such as in machining high hardness and the strength of the material, creating complex shape, obtains the better surface finish and dimensional tolerances.

One of the advanced machining processes that become the most important accepted technologies in manufacturing industries is electro discharge machining that also called die sinking EDM. Electro discharge machining (EDM) is one of the most accurate manufacturing processes for creating complex or sample shape and geometries within parts and assemblies. EDM has become a basic machining method for the manufacturing industries such as automotive, aerospace and mostly use in die-mold production.

EDM works by removes material by creating controlled sparks between a shaped electrode and an electrically conductive work piece [1]. As part of the material is eroded, the electrode is slowly lowered into the work piece, until the resulting cavity has the inverse shape of the electrode [1]. Dielectric fluid is flushed into the gap between the

electrode and work piece to remove small particles created by the process and to avoid excessive oxidation of the part surface and the electrode [1].

However, not all the melted material is flushed away completely and the remaining material resolidifies to form discharge craters. As a result, machined surface has microcracks and pores caused by high temperature gradient which reduces surface finish quality [2].

There are many published studies to determine surface finish of machined materials by EDM. From that, it was noticed that many machining parameters affect surface roughness and the combination of these parameters was difficult to produce optimum surface quality. The effect of some machining parameters such as pulsed current, pulse time, pulse pause time, voltage, dielectric liquid pressure and electrode material have been examined [2] and [3]. Previous study examined P20 tool steel and provided useful information the effects of some machining parameters on surface roughness, but the selected of pulsed current values was very low 1–8 A [4].

The aim of this project is to study the effect of machining parameters of surface roughness in EDM of tool steel (AISI D2). In this study, the surface roughness will be determined in tool steel (AISI D2). Tool steel (AISI D2), one of the carbon steels alloyed with Mo, Cr, and V, is widely used for various dies and cutters for its high strength and wear resistance due to formation of chrome carbide in heat treatment [5]. The effects of Peak Current, Pulse ON-time, Pulse OFF-time and Servo Voltage will be used to examine the surface roughness of tool steel (AISI D2).

1.2 OBJECTIVES

The aim of this study is to know more about the influences of EDM parameters on surface roughness for machining of tool steel (AISI D2) which is widely used in the production of plastic mold and die. From previous study, it was noticed that there are many machining parameters influenced surface roughness and these parameters was difficult to produce optimum surface quality. By using the different parameter such as pulse current, pulse time, pulse pause time, voltage, dielectric liquid pressure and electrode material, we will know how to obtain or produce optimum surface quality [2]. Beside, this study will generate more knowledge and experience during operating EDM.

These are summarizing of the objectives:

1. To study more about Electro Discharge Machine process.
2. To analyze the surface roughness of tool steel (AISI D2) using Electro Discharge Machine.
3. To determine the most suitable set up parameter in EDM for obtaining the good surface quality.

1.3 PROJECT SCOPES

The scopes of the project are to embrace us about machine and the material that have to cut and do the analysis. There are several scopes that will be carrying out with some result:

1. To do literature study about Electro Discharge Machining (EDM).
2. To design the experimental procedures in machining tool steel (AISI D2)
3. To conduct the experiment based on Design of Experiment (DOE).
4. To do analysis on surface roughness.

1.4 PROBLEM STATEMENT

The major research of EDM is about the ability for creating complex or sample shape parts that are mostly use in producing die and mold that require good accuracy in dimension. Moreover, the selections of parameter play an important part for obtaining good surface finish. The selection of improper parameter may result in serious consequences like produces damage such as microcracks, pores and craters on the machined surface which reduces surface finish quality.

In producing better surface quality and good accuracy in dimension, to reduce all the damage by controlling the setting of pulsed current, pulse time, pulse pause time, voltage, dielectric liquid pressure and type of electrode material [2]. In providing a variety of information in machining process, the Design of Experiment (DOE) will be performed as the methodology.

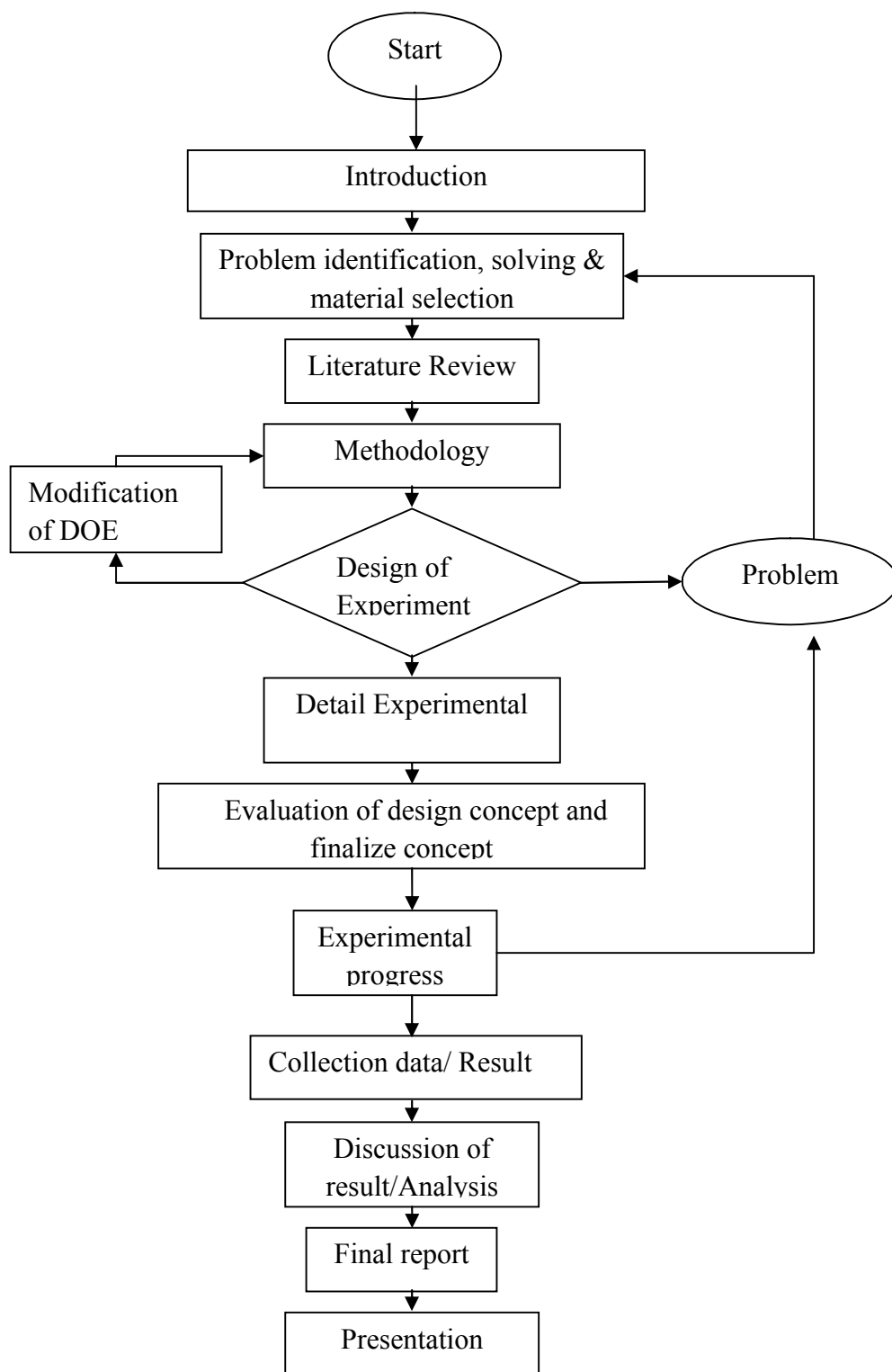


Figure 1.1: Project flow chart

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In manufacturing industry, Electro Discharge Machining (EDM) is commonly used for producing mold and die component. This machine is use because the ability of the machining process that is very accurate in creating complex or simple shape within parts and assemblies. The cost of machining is quite high payable to its initial investment and maintenance for the machine but very desirable machining process when high accuracy is required.

Many studies have been carried out for improving or finding ways to obtain good surface quality of the EDM process [2]. From the results, these study show that the machining parameter is the most important factor in producing good surface finish on the workpiece. Hence, with the information from previous studies about the effect of machining parameters on the surface roughness, the machining parameters can be set for maximum or optimum machining.

2.2 ELECRO DISCHARGE MACHINING (EDM)

This section explains the basic information about the EDM process, the capabilities and the limitation and the variations of the process combining other material removal techniques.

2.2.1 EDM process

EDM is a process that is used to remove metal through the action of an electrical discharge of short duration and high current density between the tool and the workpiece. There are no physical cutting forces between the tool and the workpiece [3].

EDM works by removes material by creating controlled sparks between a shaped electrode and an electrically conductive work piece. As part of the material is eroded, the electrode is slowly lowered into the work piece, until the resulting cavity has the inverse shape of the electrode. Dielectric fluid is flushed into the gap between the electrode and work piece to remove small particles created by the process and to avoid excessive oxidation of the part surface and the electrode [1].

The EDM process uses electrical discharges to remove material from the workpiece, with each spark producing a temperature of between 10,000-20,000°C. Consequently, the workpiece is subjected to a heat affected zone (HAZ) the top layer of which comprises recast material. The thickness, composition and condition of this layer depend on the discharge energy and the make-up of the workpiece, tool electrode and dielectric fluid, and both hard and soft surface layers can be produced despite perceived wisdom that the recast layer is always hard. With ferrous workpiece materials, the recast layer typically appears white and amorphous when viewed under a microscope, and is prone to tensile stress, microcracking and porosity [6].

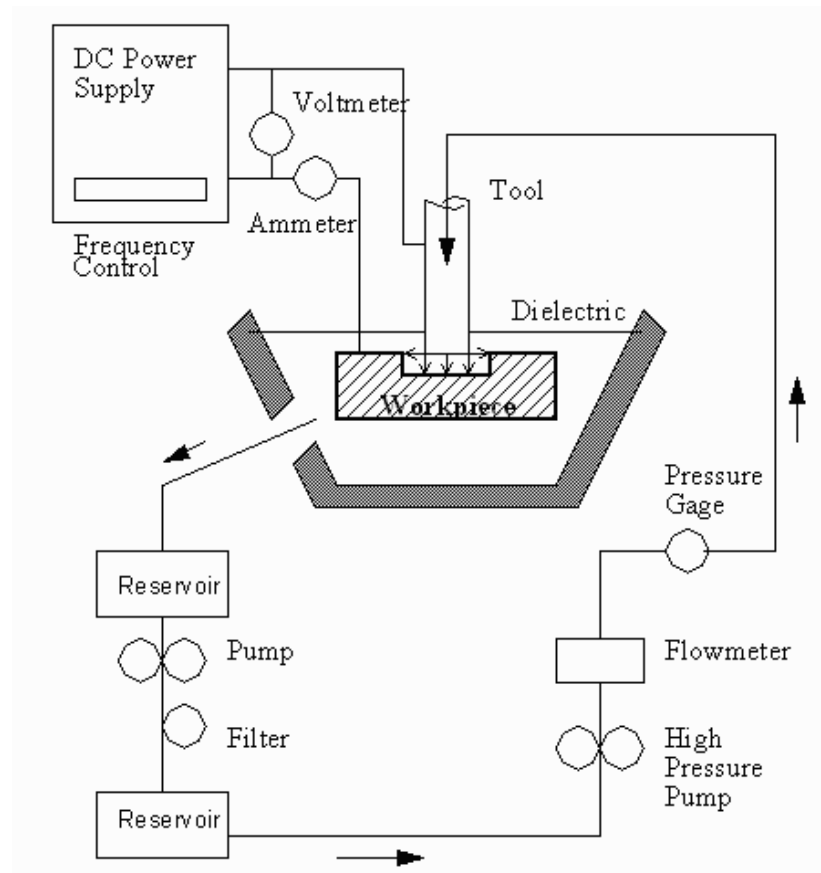


Figure 2.1: EDM process [7]

2.2.2 EDM capabilities and limitations

Capabilities

- Material of any hardness can be cut
- High accuracy and good surface finish are possible
- No cutting forces involved
- Intricate-shaped cavities can be cut with modest tooling costs
- Holes completed in one “pass”

Limitations

- Limited to electrically conductive materials
- Slow process, particularly if good surface finish and high accuracy are required
- Dielectric vapor can be dangerous
- Heat Affected Zone (HAZ) near cutting edges
- Die sinking tool life is limited

2.3 MAJOR AREAS OF EDM RESEARCH

In this section, the authors have arranged the research areas in EDM under two major headings. The first relates to machining performance measures such as surface quality (SQ) and also surveys them. The second area describes the effects of process parameters including electrical and non-electrical variables.

2.3.1 EDM process optimization

This section provides the study about the effect of the parameter in EDM process and various machining strategies. In this study, identifying the different factors and finding the different ways of EDM process play a major role to obtain the optimum machining condition and the performance. From the effective machining strategy, the result such as for producing good surface quality will be easily obtained.

2.3.1.1 EDM performance measures

Some effects of the parameters on the typical of EDM performance measures such as surface quality will be explained here. The setting and strategy for the various parameters required in EDM process play important part to produce an optimal machining parameter.